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TITLE: Psychobiological Assessment & Enhancement of Team Cohesion and Psychological Resilience in ROTC Cadets Using a Virtual-Reality Team Cohesion Test

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

NORTHERN CALIFORNIA INSTITUTE FOR RESERACH AND EDUCATION
4150 CLEMENT STREET (151NC)
SAN FRANCISCO, CA

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

US ARMY MEDICAL RESEARCH AND MATERIAL COMMAND
FORT DETRICK, MARYLAND 21702-5012

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

THE MAJORITY THAT THIS REPORTING PERIOD WAS SPENT RUNNING PARTICIPANTS THROUGH THE STUDY PROTOCOL AT OUR NEW STUDY SITE AT THE UNIVERSITY OF CALIFORNIA, BERKELEY. IN ADDITION, WE ALSO CONTINUED TO TRAIN RESEARCH STAFF, PILOT STUDY TASKS, AND CHECK THE QUALITY OF THE DATA COLLECTED. DURING THIS REPORTING PERIOD WE HAVE SUCCESSFULLY ENROLLED AND COMPLETED 114 INDIVIDUALS (38 TRIADS) AT OUR UNIVERSITY OF CALIFORNIA, BERKELEY CAMPUS SITE.

15. SUBJECT TERMS

TEAM COHESION, OXYTOCIN, PSYCHOPHYSIOLOGY, HORMONE, PROSOCOAL, UNIT, PSYCHOSOCIAL

16. SECURITY CLASSIFICATION OF: UNLIMITED DISTRIBUTION A			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
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UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	17	**19b. TELEPHONE NUMBER** *(include area code)*

TABLE OF CONTENTS

1. **INTRODUCTION:** Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

High military unit cohesion is a critical factor that enhances unit performance and promotes individual resilience to combat-related trauma. While much work has been done in defining, quantifying, and increasing unit cohesion, the precise psychobiological mechanisms that subserve unit cohesion remain unknown. The current project proposed a series of experiments that will: 1) Identify the psychological, behavioral, physiological, and hormonal predictors and mechanisms of an individual's ability to develop cohesion in a group working together as a team; and 2) Determine if administration of the prosocial neuropeptide oxytocin enhances the development of team cohesion in acquainted civilian groups. Through a deeper understanding of the underlying psychobiological predictors and mechanisms of team cohesion, the prospective identification of individuals whose unique characteristics promote or inhibit the development of group cohesion will become possible. Furthermore, if oxytocin enhances the development of team performance and cohesion, it may become a powerful performance enhancing and clinical intervention as enhanced cohesion is associated with improved Warfighter performance and resilience, and decreased susceptibility to the negative health effects of trauma exposure and combat. This would lead to significant long-term benefits to soldiers, their families, and the military.

2. **KEYWORDS:** Provide a brief list of keywords (limit to 20 words).

Team, cohesion, oxytocin, acquainted, psychophysiology, hormone, trauma, prosocial, unit, psychosocial

3. **ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction.

What were the major goals of the project?
List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project identify these dates and show actual completion dates or the percentage of completion.

The current project proposed a series of experiments that will: 1) Identify the psychological, behavioral, physiological, and hormonal predictors and mechanisms of an individual's ability to develop cohesion in a group working together as a team; and 2) Determine if administration of the pro-social neuropeptide oxytocin enhances the development of team cohesion acquainted civilian groups. Through a deeper understanding of the underlying psychobiological predictors and mechanisms of team cohesion, the prospective identification of individuals whose unique characteristics promote or inhibit the development of group cohesion will become possible. Furthermore, if oxytocin enhances the development of team performance and cohesion, it may become a powerful performance enhancing and clinical intervention as enhanced cohesion is associated with improved Warfighter performance and resilience and decreased susceptibility to the negative health effects of trauma exposure and combat. This would lead to significant long-term benefits to soldiers, their families, and the military.

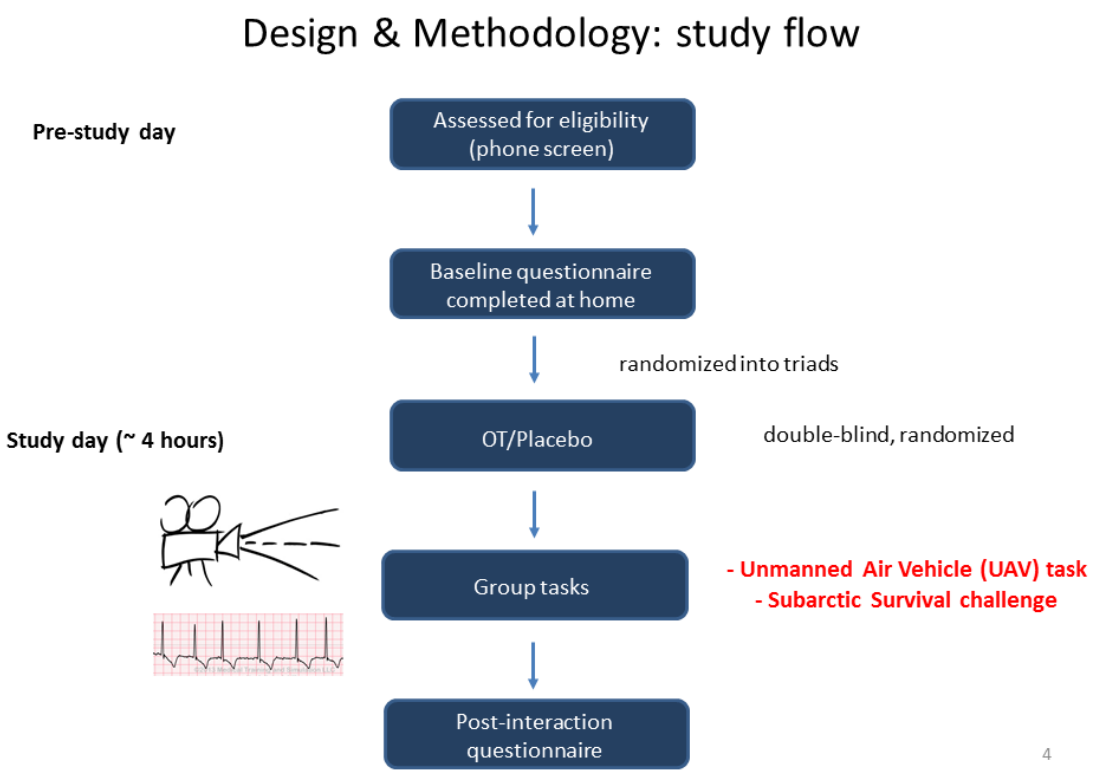
The goals for the 2nd year of this project have been to complete all preparation for the proposed experiments by: 1) Creation of appropriate study space at University of California Berkeley; 2) Assembling a new research team at University of California Berkeley; 3) Recruiting eligible civilians using study recruitment materials; 4) Successfully running groups of eligible participants at University of California Berkeley location and 5) Developing data processing protocols for the organization, cleaning, and processing of physiological and videotaped behavioral data.

What was accomplished under these goals?
For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

A. Study Protocol & Design

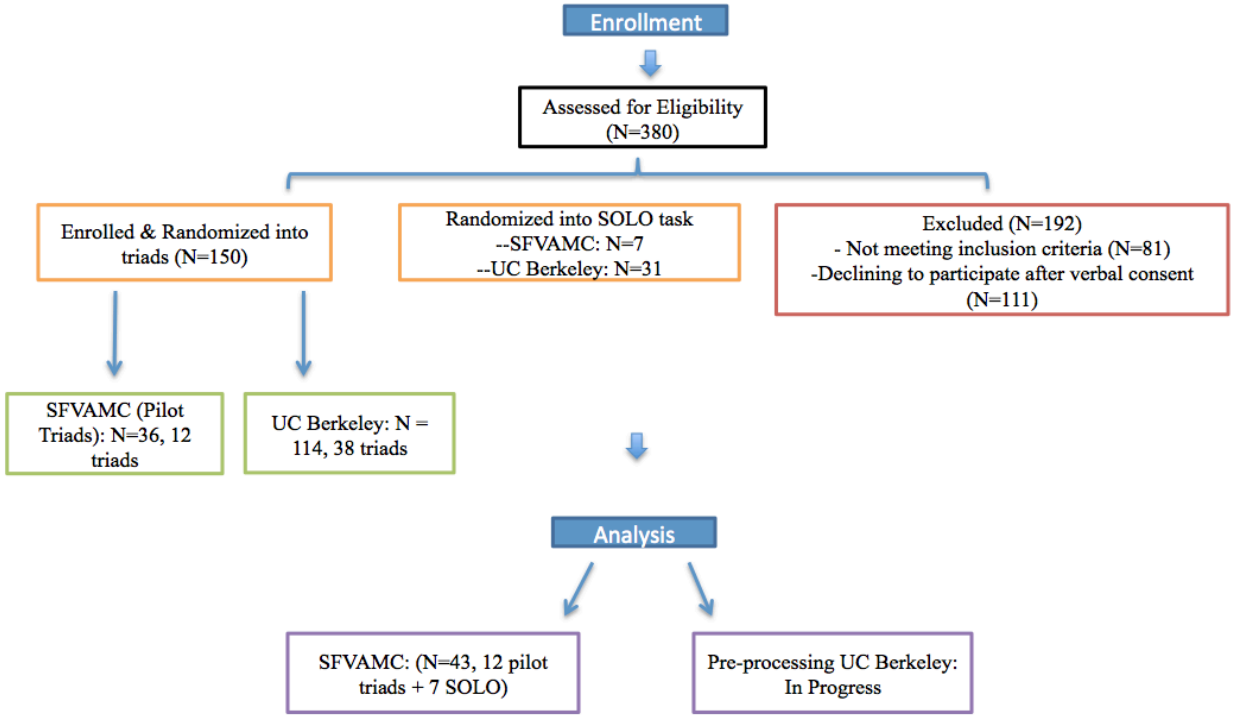
In the current, fine-tuned protocol, triads perform three missions, including a practice mission, of an Unmanned Air Vehicle (UAV) task. During this task, participants have to work together and communicate effectively in order to take as many photos as possible of designated targets while flying a virtual air vehicle. No individual has access to all the necessary information or controls, so operating as a team is crucial towards the group's success. Additionally, triads perform the Subarctic Survival Task (SST), during which they are given a crash-landing scenario and have to rank a list of items from most important to least important for the team's survival. They complete the list first as individuals and then create a new single list as a team. Interspersed with these tasks, the triads perform a get-to-know-each other and a trust game, and fill in some questionnaires. In particular, the UAV and SST tasks are designed to measure cohesion and interaction between groups. During all tasks, video and audio is recorded simultaneously with physiological responses (heart rate, impedance, skin conductance). This physiological data is still in pre-processing phase and will be analyzed in the future. See Figure 3 for a schematic summary of the study protocol.

Figure 1.



B. Study Enrollment Progress

In the last year, we have successfully screened 380 unaquainted individuals to participate in the study with an average age of 22.54 with an average education level of 14.38 years. Of those 380 unacquainted individuals, 143 are male while 237 are female. Of those individuals 48.9% are Asian, 26.5% are Caucasian, 10.4% are Latino, 10% identify as Other, 2.6% are African American, and .05% are Native American. We have run a total of 150 participants in 50 triads through our study protocol; the first 12 triads were the pilots at the San Francisco, VA Medical Center while the remainder has been at the University of California, Berkeley. See below for a diagram of our recruitment process.



C. Data Processing

In parallel with our efforts focusing on participant recruitment we have begun to develop data processing protocols for the organization, cleaning, and processing of physiological (i.e. heart rate, blood flow, and skin conductance) and videotaped behavioral data, which will be used to address our major aim of the project to identify physiological and behavioral predictors of individual's ability to work as a member of a cohesive unit. The specific steps that we will be taking regarding data processing including but not limited to:

1. Cleaning, artifact detection, and pre-processing of physiological data (i.e. heart rate, blood flow, skin conductance). The physiological data will provide us with measures of physiological arousal and physiological synchrony within the triads. The latter is especially important as an index of group cohesion and affiliation.
2. Cleaning, artifact detection, and pre-processing of movement data (i.e. bodily movements, facial expression) from video recordings. This video data will provide us with measures of synchrony as an index of group cohesion.
3. Pre-processing and transcribing of audio recordings. This audio data will provide measures of group cohesion, group roles, communication efficiency, etc.
4. Calculating group scores for group tasks (UAV task and subarctic survival task scores). This data provides measures of group performance.
5. Importing and cleaning of questionnaire data, as well as calculating scores for personality traits, trust, affiliation, etc.

As study sessions last approximately four hours, the organization and processing of a large amount of data is needed to meet our goals. To this end we have developed a training protocol for research personnel, and at the time of this report about 10% of the physiological data we have collected has been processed in this matter and we are taking the specific steps mentioned above to process and analyze the video, audio and bodily movement data.

D. Summary

We have successfully met all study goals for year 2 of this study. We have managed to add an additional study site at the University of California, Berkeley (UC Berkeley) that is more accessible to our target civilian population and have significantly increased enrollment of unacquainted triads in the last year. Additionally, we have assembled a new study team at UC Berkeley that is equipped to run the new participants. We have also made significant progress on creating data processing protocols for organizing, cleaning, and processing physiological and videotaped behavioral data.

What opportunities for training and professional development have the project provided?
If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Our current research assistants have gained significant professional developments in the past year. The research staff has increased their knowledge in the following areas:

- Researching and piloting study tasks
- Recruiting, consenting, and running study participants
- Psychophysiological data collection and processing
- Research privacy compliance
- Management of a clinical research study

How were the results disseminated to communities of interest?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

Nothing to report.

What do you plan to do during the next reporting period to accomplish the goals?
If this is the final report, state "Nothing to Report."

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

With the successful running of unacquainted participants through the study protocol at University of California, Berkeley we plan to focus on recruiting and enrolling both unacquainted and acquainted participants to meet our third year goals of completing enrollment. The current enrollment plan for both acquainted and unacquainted triads were included in the latest Statement of Work that is currently under review (submitted for review on 6/1/2017). Additionally, we plan to continue to refine our data processing plan for both the physiological and video data.

4. **IMPACT:** Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

Nothing to report.

What was the impact on other disciplines?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

Nothing to report.

What was the impact on technology transfer?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

Nothing to report.

If there is nothing significant to report during this reporting period, state "Nothing to Report."
Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

Nothing to report.

5. CHANGES/PROBLEMS: The Project Director/Principal Investigator (PD/PI) is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, "Nothing to Report," if applicable:

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

Recruitment and Retention:

Thus far, recruitment has consisted of civilians. We are recruiting both male and female same-sex triads. Recruitment of triads has been challenging for several reasons. First, we require three participants to show up simultaneously. If one or more of them drop out, this would be detrimental for the experiment. Furthermore, tardiness also proved to be a big issue because of the duration of the experiment (3.5 hours on average) and waiting time for the other participants. In order to solve these issues, we decided to reward participants for showing up on time (i.e. within 15 minutes of the start of the experiment). Secondly, we designed an additional study that can be run simultaneously with the triad study and can be performed individually. In order to increase the probability of three people always being present to run a triad, we actually recruit four participants. In case the fourth participant shows up, this participant is assigned to the individual study. The same is done in case only two people or one person show(s) up. Third, we have been denied approval by the ROTC Higher Command to run ROTC cadets through the study due to the experimental nature of Oxytocin. As a result we will only be running either unacquainted civilians or acquainted civilians through the study as specified in the latest Statement of Work (6/1/2017).

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

Recruitment and retention: Thus far, recruitment has been limited to triads consisting of civilians. We are recruiting both male and female same-sex triads. Recruitment of triads has been challenging for several reasons. First, we require three participants to show up simultaneously. If one or more of them drop out, this would be detrimental for the experiment. Furthermore, tardiness also proved to be a big issue because of the duration of the experiment (3.5 hours on average) and waiting time for the other participants. In order to solve these issues, we decided to reward participants for showing up on time (i.e. within 15 minutes of the start of the experiment). Secondly, we designed an additional study that can be run simultaneously with the triad study and can be performed individually. In order to increase the probability of three people always being present to run a triad, we actually recruit four participants. In case the fourth participant shows up, this participant is assigned to the individual study. The same is done in case only two people or one person show(s) up.

Storing of large data files: When preparing the collected data for data analysis, it became apparent that storage of the data files would have to be carefully considered. Because we are video- and audio-recording experimental sessions that can take up to four hours per triad, we are dealing with large data files that need to be stored. Furthermore, we are planning to run at least 40 triads, making consistent storage a priority. We are developing a protocol for storage, and are preparing the data for data analysis to verify and fine-tune our protocol.

Changes that had a significant impact on expenditures
Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

Nothing to report.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents
Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

No significant changes to report.

Significant changes in use or care of vertebrate animals.

N/A

Significant changes in use of biohazards and/or select agents

No significant changes to report.

5. PRODUCTS: List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state "Nothing to Report."

- **Publications, conference papers, and presentations**
  Report only the major publication(s) resulting from the work under this award.

  Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted,*

awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Nothing to report.

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report.

Other publications, conference papers, and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

Nothing to report.

- **Website(s) or other Internet site(s)**
  List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

N/A

- **Technologies or techniques**
  Identify technologies or techniques that resulted from the research activities. In addition to a description of the technologies or techniques, describe how they will be shared.

Nothing to report.

- **Inventions, patent applications, and/or licenses**

  Identify inventions, patent applications with date, and/or licenses that have resulted from the research. State whether an application is provisional or non-provisional and indicate the application number. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

  Nothing to report.

- **Other Products**

  Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment, and/or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

  - *data or databases;*
  - *biospecimen collections;*
  - *audio or video products;*
  - *software;*
  - *models;*
  - *educational aids or curricula;*
  - *instruments or equipment;*
  - *research material (e.g., Germplasm; cell lines, DNA probes, animal models);*
  - *clinical interventions;*
  - *new business creation; and*
  - *other.*

  Nothing to report.

6. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate "no change."

Name:	Josh Woolley, MD/PhD Unchanged
Name:	Sophia Vinogradov, MD Unchanged
Name:	Thomas Neylan, MD Unchanged
Name:	Wendy Mendes, PhD Unchanged
Name:	Jennifer Mitchell, PhD Unchanged
Name:	Dacher Keltner, PhD Unchanged
Name:	Lize De Coster, PhD Unchanged
Name:	Craig Anderson, PhD Unchanged
Name:	Lily Dobberteen Unchanged
Name:	Zane Ravenholt Unchanged
Name:	Lisa Lin Unchanged
Name: Project Role: Nearest person month worked: Contribution to Project:	Sandra Easterling Research assistant 2 Study management
Name: Project Role: Nearest person month worked: Contribution to Project:	Kristophe Green Research assistant 1 Study management
Name: Project Role: Nearest person month worked: Contribution to Project:	Sara Cooper Research assistant 1 Study management
Name: Project Role: Nearest person month worked: Contribution to Project:	Adrienne Van Nieuwenhuizen Research assistant 2 Study management

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to Report. The study staff remains unchanged since the Quarterly Report for Year 2 Quarter 3.

What other organizations were involved as partners?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.
Provide the following information for each partnership:

Organization name:	University of California, Berkeley
Location of Organization:	Berkeley, California
Contribution to Project:	Facilities

7. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: For collaborative awards, independent reports are required from BOTH the Initiating PI and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to **https://ers.amedd.army.mil** for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on https://www.usamraa.army.mil) should be updated and submitted with attachments.

Quad Chart Attached.

8. APPENDICES:

Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.

Quart Chart Attached

Psychobiological Assessment and Enhancement of Team Cohesion and Psychological Resilience using a Virtual Team Cohesion Test

JW140070, W81XWH-15-1-0042

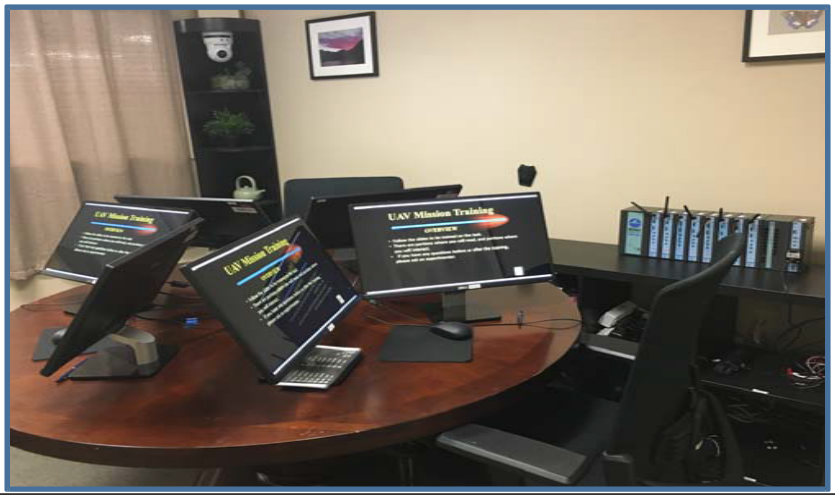
PI: Dr. Josh Woolley, MD, PhD **Org:** Northern California Institute for Research and Education (NCIRE) **Award Amount:** $1,312,556 (Directs + F&A)

Study/Product Aim(s)

•Identify the psychological, behavioral, and physiological predictors and mechanisms of team cohesion
•Examine if oxytocin administration enhances the development of group cohesion.
•Determine if oxytocin administration improves individual performance on social cognition tasks.

Approach

This is a randomized, double-blinded, placebo-controlled trial assessing the efficacy of a single administration of intranasal oxytocin dosed at 20 International Units (IU), to Reserve Officers' Training Corps (ROTC) cadets and healthy volunteers to investigate if administration of oxytocin enhances team cohesion. Cohesion is then measured using: 1) A cooperative, virtual-reality UAV flying mission, 2) the Subarctic Survival Situation task, and 3) the weakest link coordination task. To measure biobehavioral synchrony, autonomic physiology will be recorded. Behavior will be recorded and analyzed within the tasks using video recordings.



Accomplishment: Trained research assistants on all study task roles. Continuing to enroll participants and have successfully completed over thirty triads. Revised and developed study protocol to streamline enrollment. Continuing to analyze data.

Timeline and Cost

Activities CY	1	2	3
Design/Implement study protocol			
Enroll study participants			
Analyze behavioral data			
Analyze physiological data			
Estimated Budget ($1,312,556)	**$437,514**	**$436,515**	**$438,527**

Updated: June 26, 2017

Goals/Milestones

CY1 Goal – Design Tasks and Recruit Participants
☑ Functionality test of study tasks
☑ Train research assistants on study protocol
☑ Focus on enrollment of participants

CY2 Goals – Increase Enrollment of Study Participants
☑ Continue enrollment of participants
☑ Validate and analyze behavioral/physiological data

CY3 Goal – Complete Recruitment and Data Analysis
☐ Complete enrollment of study participants
☐ Complete behavioral/physiological data analysis

Comments/Challenges/Issues/Concerns
- Study is adhering to scheduled enrollment plans

Budget Expenditure to Date (06/30/2017) Projected Expenditure: $874,029 (Direct + F&A) Actual Expenditure: **$631,950** (Directs + F&A)